MANIFESTATION OF HYBRID VIGOUR IN DIFFERENT CROSSES OF THE SILKWORM, *BOMBYX MORI* L.

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ABSTRACT

Heterosis over check parent value was observed by using five imported hybrids which imported from China, Bulgaria and Turkey. Thirty seven of single local hybrids were examined. Resulted data revealed that, there are some promising hybrids which can be used for commercial production.

INTRODUCTION

The main aim of the silkworm breeding is not only to synthesis new genotype but also to adjudicate the productive hybrids for commercial exploitation. Silkworm breeding contains two distinct strategies, the first is establishment of inbred lines by selection of qualitative and quantitative characters at successive generations; and the second is selection off suitable hybrids for commercial use. These two objectives will be achieved only when widely varied and distinctly divergent gene pools are created in the parent silkworm races. So that high degree of heterosis will be exhibited in the hybrid (Thangavelu, 1998).

The present study was carried out to elucidate the manifestation of hybrid vigour in different local single hybrids over five F_1 hybrids imported from different countries.

MATERIAL AND METHODS

Five F_1 hybrids imported from different countries during Spring 2006 were used as check hybrids. These hybrids namely HQIX.XJIUF and HBBX.DT which were imported from China and coded as China 1 and China 2, respectively. Hybrids of $C_1X.X_2$ and Bp35X M_2 from Bulgaria and coded as Bulgaria 1 and Bulgaria 2. And Japon X Cin from Turkey and coded as Turkey.

Ten local races of silkworm *Bombyx mori* L. were used for hybridization. These races were obtained from Sericulture Research Department-Giza- Egypt.

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These races namely EchP, DchP, NoviP, NoviM, DjP, DjM, EjP, EjM, 380 and SA105P are coded as A, B, C, D, E, F, G, H, I and K, respectively.

Cross systems were made by using males of race D mated with E, F, H, I and K. Females of A, B, E, G, H and I were crossed with males of race K. C males were mated with B, D, E, F, H and G females. Males of race B were crossed with A, C, I and K females. Also, males of F mated with females of B, D, E and H. G males were crossed with E, F, and K. H males were mated with females of A, C, F, and K. Males of race I were crossed with H and K. Males of race A were mated with females of B and F. So, thirty seven single hybrids were obtained.

Silkworm rearing was carried out according to Krinshsyami 1978. Three replicates from each hybrid were reared during Spring season of 2006 (April- May) under the laboratory normal conditions at 22.79°C and 75.34 % RH. Three hundred larvae were retained after third moult per each replicate. Data were accrued for nine economic traits namely cocoon weight (CW), cocoon shell weight (CSW), pupal weight (PW), cocoon shell ratio (CSR), silk productivity (SP), fifth instar duration (FID), total larval duration (LD), pupation ratio (PR) and double cocoon percentage (DCP). The weights of cocoon, cocoon shell and pupa were recorded by gram, while cocoon shell ratio, pupation ratio and double cocoon percentage were as percentages, fifth instar duration and total larval duration recoded by day and silk productivity were recorded by centigram/day.

Cocoon shell ratio for each entry was calculated according to Tanaka (1964) as follows:

Silk productivity was estimated by using formula of Chattopadhyay *et al.*, (1995).

$$Cocoon\ shell\ ratio\ (\%) = \frac{cocoon\ shell\ weight}{fresh\ cocoon\ weight} x100$$

$$Silk\ productivity\ (cg/day) = \frac{Cocoon\ shell\ weight\ (cg)}{fifth\ instar\ duration\ (day)}$$

Where cg: Centigram

Double cocoon percentage and pupation ratio were calculated according to the following formulae of Lea (1996):

$$Double\ cocoon\ percentage\ (\%) = \frac{Number\ of\ pupae\ made\ double\ cocoon}{Total\ number\ of\ pupae\ harvested}$$

$$Pupation\ ratio\ (\%) = \frac{Number\ of\ health\ pupae}{Corrected\ basic\ number\ of\ examined}$$

Heterosis was calculated according the formula of SINGH *et al.*, (2002) as follows:

$$Heterosis\ over\ CPV = \frac{F_1 - CPV}{CPV} X\,100$$

Where CPV: Check Parent Value

RESULTS AND DISCUSSION

Positive hybrid vigour is desirable for cocoon weight, cocoon shell weight. pupal weight, cocoon shell ratio, silk productivity and pupation ratio. While, negative hybrid vigour is desirable for fifth instar duration, total larval duration and double cocoon percentage.

Twelve single local hybrids represent heterosis over check parent China 1 for cocoon weight (CW), cocoon shell weight (CSW), pupal weight (PW), cocoon shell ratio (CSR), silk productivity (SP), fifth instar duration(FID), total larval duration (LD), pupation ratio (PR) and double cocoon percentage (DCP) traits. While, six of single local hybrids showed hybrid vigour over check hybrid China 2 for all pervious characters. Three single local hybrids acquired heterosis aver check hybrids China 1and China2 together (Table, 1 and 2).

Hybrid of KXI earned best heterosis value over check hybrid Bulgaria 1, and six single local hybrids represented hybrid vigour for all character under study except double cocoon percentage (Table, 3).

Only KXD hybrid showed hybrid vigour over check hybrid Bulgaria 2 for all characters except pupal weight trait. Also, most of single hybrid represented hybrid vigour over check hybrid Bulgaria 2 for fifth instar duration, total larval duration and pupation ratio (Table, 4).

Eleven single local hybrids showed hybrid vigour over check hybrid Turkey for all characters (Table, 5).

TABLE (I)

Heterosis value over check hybrid China 1 of some single local hybrids of silkworm, *Bombyx mori* L.

	CW	CSW	PW	CSR	FID	SP	LD	DCP	PR
AxB	33.023	28.812	33.747	-3.598	-18.182	57.437	-14.634	-55.529	6.487
AxH	37.391	32.363	37.806	-4.919	-18.182	61.777	4.878	22.429	10.124
AXK	49.278	46.283	47.877	-2.974	-18.182	78.790	-14.634	-100.000	-66.840
BxA	17.716	26.449	12.032	6.854	-18.182	54.549	-14.634	-14.286	10.314
BxC	4.844	-8.249	37.277	-13.404	-18.182	12.140	-14.634	-19.775	13.055
BxF	7.285	10.702	5.320	2.511	-27.273	52.216	-15.141	-72.231	5.012
BxK	13.509	2.260	16.250	-10.885	-18.182	24.985	-12.195	-52.897	2.226
CXB	4.467	17.435	6.359	10.964	-18.182	43.532	-15.141	-61.818	-17.994
CXE	32.806	24.630	33.890	-6.967	-18.182	52.325	-14.634	-74.154	8.675
CXH	36.265	54.717	31.813	26.035	-18.182	89.098	-14.634	-73.120	11.900
DxC	-3.396	-13.619	-0.407	-12.091	-18.182	5.577	-7.824	-100.000	-19.936
DXE	24.509	27.842	22.237	2.311	-18.182	56.252	-14.634	-80.909	8.747
DxF	36.147	41.797	33.857	3.372	-18.182	73.307	-14.634	-76.986	12.154
ExD	15.489	29.302	15.941	11.884	-27.273	77.790	-15.141	-100.000	11.450
EXF	31.227	18.000	31.174	-10.753	-27.273	62.250	-14.634	-89.608	0.989
EXG	48.076	47.727	50.003	-1.045	-18.182	80.555	-12.195	-54.389	3.825
EXK	38.207	49.830	41.606	7.095	-18.182	83.125	-15.141	1.434	5.712
FxA	36.238	39.561	36.246	1.071	-18.182	70.575	-14.634	-63.741	13.690
FxC	5.320	-5.505	6.916	-11.399	-18.182	15.494	-14.634	-85.517	11.292
FxD	33.959	48.369	29.954	7.330	-18.182	81.340	-14.634	-67.898	11.559
FXG	47.240	42.823	48.855	-3.915	-18.182	74.561	-14.634	-75.000	8.523
FxH	7.500	-7.874	10.081	-15.510	-27.273	26.673	-10.263	-75.111	11.219
GXC	30.232	20.949	54.742	-7.529	-18.182	47.827	-14.634	-54.595	12.341
GXK	32.939	39.530	36.913	4.072	-18.182	70.537	-14.634	-100.000	12.154
HXC	44.940	42.180	44.381	-3.538	-18.182	73.776	-14.634	-60.681	8.828
HxD	18.560	21.845	15.907	0.751	-27.273	67.537	-12.195	-100.000	12.353
HXF	29.241	22.210	33.426	-6.342	-27.273	68.039	-14.634	-45.806	10.138
HX I	26.671	14.789	23.715	-8.512	-18.182	40.297	-14.634	-82.128	13.089
HXK	-18.232	-26.033	-17.072	-11.603	-9.091	-18.637	-12.195	-100.000	-4.817
IXB	37.187	44.608	34.771	4.903	-18.182	76.743	-14.634	26.575	10.659
IXD	27.163	35.767	24.560	5.732	-9.091	49.344	-14.634	-84.587	2.415
IXK	22.401	21.927	22.187	-1.300	-18.182	49.021	-14.634	-70.228	9.265
KXB	29.896	29.367	29.310	-1.265	-18.182	58.115	-14.634	-64.507	9.081
KXD	56.525	57.506	30.534	15.673	-18.182	92.508	-14.634	-77.091	0.854
KXG	21.798	15.479	21.768	-6.215	-18.182	41.141	-14.634	-10.796	10.275
KXH	12.755	0.530	15.066	-11.556	-27.273	38.229	-17.580	-22.581	3.659
KXI	42.690	45.455	38.351	2.578	-18.182	77.778	-14.634	-100.000	-11.179

Where CW: cocoon weight, CSW: cocoon shell weight, PW: pupal weight, CSR: cocoon shell ratio, SP: silk productivity, FID: fifth instar duration, LD: total larval duration, PR: pupation ratio and DCP: double cocoon percentage.

TABLE (II)

Heterosis value over check hybrid China 2 of some single local hybrids of silkworm, *Bombyx mori* L.

	CW	CSW	PW	CSR	FID	SP	LD	DCP	PR
AxB	31.081	20.144	33.095	-8.031	0.000	20.144	-10.256	-21.471	17.343
AxH	35.386	23.456	37.135	-9.292	0.000	23.456	10.256	116.194	21.351
AXK	47.099	36.439	47.156	-7.436	0.000	36.439	-10.256	-100.000	-63.460
BxA	15.998	17.940	11.486	1.940	0.000	17.940	-10.256	51.361	21.560
BxC	3.314	-14.424	36.609	-17.386	0.000	-14.424	-10.256	41.667	24.581
BxF	5.719	3.253	4.807	-2.203	-11.111	16.159	-10.790	-50.964	15.717
BxK	11.852	-4.621	15.684	-14.983	0.000	-4.621	-7.692	-16.822	12.648
CXB	2.942	9.533	5.841	5.861	0.000	9.533	-10.790	-32.576	-9.633
CXE	30.868	16.243	33.237	-11.245	0.000	16.243	-10.256	-54.359	19.754
CXH	34.275	44.305	31.170	20.239	0.000	44.305	-10.256	-52.533	23.308
DxC	-4.806	-19.432	-0.892	-16.134	0.000	-19.432	-3.097	-100.000	-11.774
DXE	22.691	19.239	21.641	-2.394	0.000	19.239	-10.256	-66.288	19.834
DxF	34.159	32.255	33.205	-1.382	0.000	32.255	-10.256	-59.361	23.588
ExD	13.803	20.601	15.376	6.739	-11.111	35.676	-10.790	-100.000	22.812
EXF	29.311	10.059	30.535	-14.858	-11.111	23.817	-10.256	-81.649	11.284
EXG	45.915	37.786	49.272	-5.596	0.000	37.786	-7.692	-19.457	14.409
EXK	34.249	30.169	35.582	-3.577	0.000	30.169	-10.256	79.119	16.489
FxA	3.782	-11.864	6.395	-15.473	0.000	-11.864	-10.256	-35.971	25.281
FxC	32.004	38.385	29.321	2.394	0.000	38.385	-10.256	-74.425	22.638
FxD	45.091	33.211	48.130	-8.333	0.000	33.211	-10.256	-43.312	22.932
FXG	5.931	-14.073	9.545	-19.396	-11.111	-3.333	-5.662	-55.853	19.586
FxH	36.189	39.747	40.916	2.170	0.000	39.747	-10.790	-56.049	22.557
GXC	28.331	12.810	53.988	-11.781	0.000	12.810	-10.256	-19.820	23.794
GXK	30.999	30.140	36.246	-0.714	0.000	30.140	-10.256	-100.000	23.588
HXC	42.824	32.612	43.677	-7.974	0.000	32.612	-10.256	-30.567	19.923
HxD	16.829	13.646	15.343	-3.882	-11.111	27.851	-7.692	-100.000	23.807
HXF	27.354	13.986	32.776	-10.649	-11.111	28.234	-10.256	-4.301	21.366
HX I	24.822	7.064	23.113	-12.719	0.000	7.064	-10.256	-68.440	24.618
HXK	-19.426	-31.011	-17.476	-15.668	11.111	-37.910	-7.692	-100.000	4.886
IXB	35.184	34.876	34.114	0.079	0.000	34.876	-10.256	123.516	21.940
IXD	25.307	26.631	23.953	0.870	11.111	13.968	-10.256	-72.783	12.856
IXK	20.614	13.722	21.592	-5.838	0.000	13.722	-10.256	-47.426	20.404
KXB	27.999	20.661	28.680	-5.805	0.000	20.661	-10.256	-37.324	20.202
KXD	54.240	46.907	29.898	10.354	0.000	46.907	-10.256	-59.545	11.136
KXG	20.020	7.708	21.174	-10.528	0.000	7.708	-10.256	57.522	21.517
KXH	11.109	-6.235	14.505	-15.624	-11.111	5.486	-13.354	36.713	14.227
KXI	40.607	35.666	37.677	-2.140	0.000	35.666	-10.256	-100.000	-2.124

Where CW: cocoon weight, CSW: cocoon shell weight, PW: pupal weight, CSR: cocoon shell ratio, SP: silk productivity, FID: fifth instar duration, LD: total larval duration, PR: pupation ratio and DCP: double cocoon percentage.

TABLE (III)

Heterosis value over check hybrid Bulgaria 1 of some single local hybrids of silkworm, *Bombyx mori* L.

	CW	CSW	PW	CSR	FID	SP	LD	DCP	PR
AxB	-0.880	0.294	-0.260	1.945	0.000	0.294	-7.895	128.971	21.276
AxH	2.375	3.059	2.767	0.548	0.000	3.059	13.158	31.061	23.850
AXK	11.232	13.897	10.277	2.605	0.000	13.897	-7.895	-100.000	-62.235
BxA	-12.286	-1.546	-16.454	12.998	0.000	-1.546	-7.895	341.327	25.634
BxC	-21.877	-28.562	2.373	-8.425	0.000	-28.562	-7.895	313.062	28.756
BxF	-20.058	-13.806	-21.459	8.406	-11.111	-3.032	-8.442	42.975	19.596
BxK	-15.420	-20.379	-13.308	-5.761	0.000	-20.379	-5.263	142.523	16.423
CXB	-22.158	-8.564	-20.684	17.345	0.000	-8.564	-8.442	96.591	-6.605
CXE	-1.042	-2.962	-0.154	-1.617	0.000	-2.962	-7.895	33.077	23.767
CXH	1.535	20.464	-1.703	33.282	0.000	20.464	-7.895	38.400	27.441
DxC	-28.017	-32.743	-25.730	-7.037	0.000	-32.743	-0.547	-100.000	-8.817
DXE	-7.224	-0.461	-8.844	8.193	0.000	-0.461	-7.895	-1.705	23.850
DxF	1.447	10.404	-0.178	9.315	0.000	10.404	-7.895	18.493	27.730
ExD	-13.945	0.675	-13.539	18.317	-11.111	13.260	-8.442	-100.000	26.928
EXF	-2.218	-8.124	-2.179	-5.622	-11.111	3.360	-7.895	-46.495	15.014
EXG	10.337	15.021	11.863	4.645	0.000	15.021	-5.263	134.842	18.244
EXK	2.983	16.658	5.601	13.253	0.000	16.658	-8.442	422.264	20.393
FxA	1.516	8.663	1.603	6.882	0.000	8.663	-7.895	86.691	29.480
FxC	-21.523	-26.426	-20.269	-6.304	0.000	-26.426	-7.895	-25.431	26.748
FxD	-0.182	15.521	-3.088	13.501	0.000	15.521	-7.895	65.287	27.052
FXG	9.714	11.203	11.006	1.610	0.000	11.203	-7.895	28.720	23.594
FxH	-19.898	-28.270	-17.908	-10.652	-11.111	-19.304	-3.179	28.148	26.665
GXC	-2.960	-5.828	15.397	-2.212	0.000	-5.828	-7.895	133.784	27.943
GXK	-0.942	8.639	2.101	10.056	0.000	8.639	-7.895	-100.000	27.730
HXC	8.000	10.703	7.670	2.008	0.000	10.703	-7.895	102.447	23.942
HxD	-11.657	-5.131	-13.564	6.544	-11.111	6.728	-5.263	-100.000	27.956
HXF	-3.698	-4.846	-0.500	-0.957	-11.111	7.048	-7.895	179.032	25.434
HX I	-5.613	-10.625	-7.741	-3.251	0.000	-10.625	-7.895	-7.979	28.795
HXK	-39.072	-42.409	-38.157	-6.520	11.111	-48.168	-5.263	-100.000	8.402
IXB	2.222	12.593	0.503	10.935	0.000	12.593	-7.895	551.712	26.027
IXD	-5.246	5.709	-7.111	11.812	11.111	-4.862	-7.895	-20.642	16.639
IXK	-8.795	-5.067	-8.881	4.376	0.000	-5.067	-7.895	53.291	24.439
KXB	-3.210	0.726	-3.569	4.412	0.000	0.726	-7.895	82.746	24.231
KXD	16.632	22.636	-2.656	22.324	0.000	22.636	-7.895	17.955	14.861
KXG	-9.244	-10.087	-9.194	-0.823	0.000	-10.087	-7.895	359.292	25.590
KXH	-15.982	-21.726	-14.191	-6.471	-11.111	-11.942	-11.074	298.618	18.055
KXI	6.323	13.252	3.173	8.476	0.000	13.252	-7.895	-100.000	1.156

Where CW: cocoon weight, CSW: cocoon shell weight, PW: pupal weight, CSR: cocoon shell ratio, SP: silk productivity, FID: fifth instar duration, LD: total larval duration, PR: pupation ratio and DCP: double cocoon percentage.

TABLE (IV)

Heterosis value over check hybrid Bulgaria 2 of some single local hybrids of silkworm, *Bombyx mori* L.

	CW	CSW	PW	CSR	FID	SP	LD	DCP	PR
AxB	-6.840	-13.318	-2.869	-6.461	-18.182	5.945	-16.667	87.941	25.325
AxH	-3.781	-10.928	0.079	-7.742	-18.182	8.865	2.381	7.576	27.985
AXK	4.543	-1.561	7.393	-5.855	-18.182	20.314	-16.667	-100.000	-60.974
BxA	-17.560	-14.908	-18.639	3.681	-18.182	4.001	-16.667	262.245	29.828
BxC	-26.575	-38.258	-0.305	-15.975	-18.182	-24.537	-16.667	239.045	33.055
BxF	-24.865	-25.505	-23.513	-0.532	-27.273	2.431	-17.162	17.355	23.589
BxK	-20.506	-31.185	-15.575	-13.531	-18.182	-15.893	-14.286	99.065	20.310
CXB	-26.839	-20.974	-22.759	7.670	-18.182	-3.412	-17.162	61.364	-3.486
CXE	-6.992	-16.132	-2.765	-9.729	-18.182	2.505	-16.667	9.231	27.900
CXH	-4.570	4.114	-4.274	22.293	-18.182	27.251	-16.667	13.600	31.696
DxC	-32.346	-41.871	-27.672	-14.701	-18.182	-28.954	-10.019	-100.000	-5.773
DXE	-12.803	-13.971	-11.228	-0.727	-18.182	5.147	-16.667	-19.318	27.985
DxF	-4.653	-4.580	-2.789	0.302	-18.182	16.624	-16.667	-2.740	31.995
ExD	-19.120	-12.988	-15.800	8.562	-27.273	19.641	-17.162	-100.000	31.166
EXF	-8.098	-20.594	-4.737	-13.403	-27.273	9.183	-16.667	-56.082	18.854
EXG	3.702	-0.589	8.937	-3.983	-18.182	21.502	-14.286	92.760	22.192
EXK	-3.210	0.825	2.839	3.916	-18.182	23.231	-17.162	328.679	24.413
FxA	-4.589	-6.085	-1.054	-1.930	-18.182	14.786	-16.667	53.237	33.803
FxC	-26.242	-36.411	-22.354	-14.030	-18.182	-22.280	-16.667	-38.793	30.980
FxD	-6.185	-0.157	-5.623	4.143	-18.182	22.030	-16.667	35.669	31.294
FXG	3.116	-3.890	8.103	-6.768	-18.182	17.468	-16.667	5.655	27.721
FxH	-24.715	-38.005	-20.055	-18.019	-27.273	-14.757	-12.400	5.185	30.894
GXC	-8.795	-18.609	12.379	-10.275	-18.182	-0.522	-16.667	91.892	32.215
GXK	-6.899	-6.105	-0.569	0.982	-18.182	14.760	-16.667	-100.000	31.995
HXC	1.506	-4.322	4.854	-6.402	-18.182	16.940	-16.667	66.170	28.080
HxD	-16.969	-18.006	-15.824	-2.241	-27.273	12.741	-14.286	-100.000	32.229
HXF	-9.489	-17.761	-3.102	-9.123	-27.273	13.079	-16.667	129.032	29.621
HX I	-11.289	-22.755	-10.154	-11.228	-18.182	-5.589	-16.667	-24.468	33.095
HXK	-42.736	-50.225	-39.775	-14.227	-9.091	-45.248	-14.286	-100.000	12.021
IXB	-3.925	-2.689	-2.125	1.789	-18.182	18.936	-16.667	434.932	30.235
IXD	-10.944	-8.638	-9.541	2.593	-9.091	0.499	-16.667	-34.862	20.533
IXK	-14.279	-17.951	-11.264	-4.230	-18.182	0.282	-16.667	25.823	28.594
KXB	-9.031	-12.945	-6.091	-4.197	-18.182	6.401	-16.667	50.000	28.378
KXD	9.619	5.991	-5.202	12.239	-18.182	29.545	-16.667	-3.182	18.696
KXG	-14.702	-22.290	-11.569	-9.000	-18.182	-5.021	-16.667	276.991	29.783
KXH	-21.034	-32.350	-16.436	-14.182	-27.273	-6.981	-19.543	227.189	21.997
KXI	-0.071	-2.119	0.475	-0.468	-18.182	19.633	-16.667	-100.000	4.533

Where CW: cocoon weight, CSW: cocoon shell weight, PW: pupal weight, CSR: cocoon shell ratio, SP: silk productivity, FID: fifth instar duration, LD: total larval duration, PR: pupation ratio and DCP: double cocoon percentage.

TABLE (V)

Heterosis value over check hybrid Turkey of some single local hybrids of silkworm, *Bombyx mori* L.

	CW	CSW	PW	CSR	FID	SP	LD	DCP	PR
AxB	3.819	5.682	4.118	1.802	0.000	5.682	-10.256	-37.353	7.845
AxH	7.228	8.595	7.278	0.407	0.000	8.595	10.256	-64.141	10.135
AXK	16.505	20.015	15.117	2.462	0.000	20.015	-10.256	-100.000	-66.417
BxA	-8.128	3.743	-12.786	12.839	0.000	3.743	-10.256	20.748	11.721
BxC	-18.174	-24.725	6.866	-8.553	0.000	-24.725	-10.256	13.015	14.498
BxF	-16.268	-9.176	-18.012	8.254	-11.111	2.177	-10.790	-60.882	6.351
BxK	-11.411	-16.102	-9.503	-5.893	0.000	-16.102	-7.692	-33.645	3.530
CXB	-18.468	-3.652	-17.203	17.180	0.000	-3.652	-10.790	-46.212	-16.948
CXE	3.649	2.250	4.229	-1.755	0.000	2.250	-10.256	-63.590	10.061
CXH	6.348	26.935	2.612	33.096	0.000	26.935	-10.256	-62.133	13.328
DxC	-24.605	-29.130	-22.470	-7.167	0.000	-29.130	-3.097	-100.000	-18.915
DXE	-2.826	4.886	-4.843	8.042	0.000	4.886	-10.256	-73.106	10.135
DxF	6.256	16.335	4.203	9.162	0.000	16.335	-10.256	-67.580	13.585
ExD	-9.866	6.084	-9.743	18.151	-11.111	19.344	-10.790	-100.000	12.872
EXF	2.417	-3.189	2.115	-5.754	-11.111	8.912	-10.256	-85.361	2.277
EXG	15.567	21.200	16.773	4.498	0.000	21.200	-7.692	-35.747	5.149
EXK	7.864	22.925	10.236	13.095	0.000	22.925	-10.790	42.893	7.061
FxA	6.328	14.501	6.063	6.732	0.000	14.501	-10.256	-48.921	15.141
FxC	-17.803	-22.473	-16.769	-6.435	0.000	-22.473	-10.256	-64.782	9.907
FxD	4.549	21.727	1.165	13.343	0.000	21.727	-10.256	-79.598	12.712
FXG	14.915	17.176	15.879	1.468	0.000	17.176	-10.256	-54.777	12.982
FxH	-16.101	-24.417	-14.305	-10.777	-11.111	-14.969	-5.662	-64.938	12.638
GXC	1.640	-0.769	20.462	-2.349	0.000	-0.769	-10.256	-36.036	13.774
GXK	3.753	14.475	6.583	9.902	0.000	14.475	-10.256	-100.000	13.585
HXC	13.119	16.650	12.396	1.866	0.000	16.650	-10.256	-44.610	10.216
HxD	-7.469	-0.034	-9.770	6.395	-11.111	12.462	-7.692	-100.000	13.786
HXF	0.867	0.265	3.868	-1.096	-11.111	12.799	-10.256	-23.656	11.543
HX I	-1.139	-5.824	-3.691	-3.387	0.000	-5.824	-10.256	-74.823	14.532
HXK	-36.184	-39.315	-35.443	-6.651	11.111	-45.384	-7.692	-100.000	-3.603
IXB	7.068	18.641	4.915	10.780	0.000	18.641	-10.256	78.311	12.070
IXD	-0.755	11.388	-3.034	11.655	11.111	0.249	-10.256	-78.287	3.722
IXK	-4.471	0.033	-4.881	4.230	0.000	0.033	-10.256	-58.059	10.658
KXB	1.378	6.137	0.664	4.266	0.000	6.137	-10.256	-50.000	10.473
KXD	22.161	29.224	1.617	22.153	0.000	29.224	-10.256	-67.727	2.141
KXG	-4.942	-5.257	-5.208	-0.961	0.000	-5.257	-10.256	25.664	11.682
KXH	-11.999	-17.521	-10.425	-6.602	-11.111	-7.212	-13.354	9.063	4.981
KXI	11.363	19.336	7.702	8.324	0.000	19.336	-10.256	-100.000	-10.046

Where CW: cocoon weight, CSW: cocoon shell weight, PW: pupal weight, CSR: cocoon shell ratio, SP: silk productivity, FID: fifth instar duration, LD: total larval duration, PR: pupation ratio and DCP: double cocoon percentage.

From the pervious results it could be concluded that there are some promising hybrids which can used for commercial production. These results are in accordance with those found by Rajalakshmi *et al.*, (1998) and Ghazy (2005) who studied heterosis on rearing and cocoon characters of some hybrids of silkworm, *Bombyx mori* L. Data revealed that some hybrids were highly promising over the existing checks hybrid.

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